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(71) Applicant *(for all designated States except US)*: ISIS INNOVATION LIMITED [GB/GB]; 2 South Parks Road, Oxford OX1 3UB (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: LALVANI, Ajit [GB/GB]; 39 Lonsdale Road, Oxford OX2 7ES (GB). BROOKES, Roger, Hamilton [GB/GB]; Leaf Cottage, 43 Manor Road, Old Woodstock, Oxford OX20 1XP (GB).

(74) Agent: PENNANT, Pyers; Stevens Hewlett & Perkins, 1 Serjeants' Inn, Fleet Street, London EC4Y 1LL (GB).

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(54) Title: ASSAY METHOD FOR PEPTIDE SPECIFIC T-CELLS

(57) Abstract

A method of assaying for peptide-specific T-cells comprises adding peptide to a fluid sample of fresh peripheral blood mononuclear cells, and detecting a cytokine such as interferon-γ produced by T-cells that have been pre-sensitised to the peptide. The assay method is quick and cheap and is expected to be useful for the study of various disease states including Hepatitis B, Hepatitis C, tuberculosis, malaria, HIV and influenza.

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ASSAY METHOD FOR PEPTIDE SPECIFIC T-CELLS

This invention is concerned with a method of assaying for activated peptide-specific T-cells. It is a development of the known ELISPOT assay, which is reviewed in current protocols in Immunology, Unit 6.19, pages 6.19.1-8.

The filter immunoplaque assay, otherwise called the enzyme-linked immunospot assay (ELISPOT), was initially developed to detect and quantitate individual antibody-secreting B cells. At the time it was developed, the technique provided a rapid and versatile alternative to conventional plaque-forming cell assays. Recent modifications have improved the sensitivity of the ELISPOT assay such that cells producing as few as 100 molecules of specific protein per second can be detected. These assays take advantage of the relatively high concentration of a given protein (such as a cytokine) in the environment immediately surrounding the protein-secreting cell. These cell products are captured and detected using high-affinity antibodies.

The ELISPOT assay utilises two high-affinity cytokine-specific antibodies directed against different epitopes on the same cytokine molecule: either two monoclonal antibodies or a combination of one monoclonal antibody and one polyvalent antiserum. ELISPOT generates spots based on a colorimetric reaction that detects the cytokine secreted by a single cell. The spot represents a "footprint" of the original cytokine-producing cell. Spots are permanent and can be quantitated visually, microscopically, or electronically.

The ELISPOT assay involves five specific steps: (1) coating a purified cytokine-specific antibody to a nitrocellulose-backed microtitre plate; (2) blocking the plate to prevent nonspecific absorption of any other

proteins, (3) incubating the cytokine-secreting cells at several different dilutions; (4) adding a labelled second anti-cytokine antibody; and (5) detecting the antibody-cytokine complex.

In this invention, the technique has been used to develop an assay for peptide-specific T-cells that have been pre-sensitised *in vivo* to a particular peptide.

Thus the present invention provides a method of assaying for peptide-specific T-cells, which method comprises providing a fluid containing T-cells, adding a peptide to the fluid, incubating the fluid to cause cytokine release, and detecting the released cytokine. Preferably the method comprises providing the fluid containing T-cells in contact with a surface carrying an immobilised first antibody to the cytokine, adding the peptide to the fluid, incubating the resulting fluid mixture under conditions to cause any peptide-specific T-cells that have been pre-sensitised *in vivo* to the peptide to secrete the cytokine, and detecting any secreted cytokine bound to the immobilised first antibody.

The cells are preferably peripheral blood mononuclear cells (PMBC).They may suitably be taken from a patient known to be suffering, or to have suffered, from an infection with an intracellular pathogen, e.g. a virus. It is a preferred feature of the invention that fresh cells are used, because cells cultured *in vitro* may develop altered characteristics thus reducing the diagnostic value of the assay. The purpose of the assay is to identify or quantitate peptide-specific T-cells e.g. CD8+ or CD4+ cells that have been activated or pre-sensitised *in vivo* to a particular peptide. These are unrestimulated T-cells, i.e. cells capable of immediate effector function without the need to effect division/differentiation by *in vitro* culture. When the peptide in question is presented to such cells, the cells secrete various cytokines, of which any one may be selected for the purposes of this assay. Preferably the cytokine selected is interferon-γ (IFN-γ).

The secreted cytokine can be detected by any of a variety of methods known in the literature. Preferably the assay method involves providing a surface carrying an immobilised first antibody to the IFN-γ or other cytokine. A fluid containing the PBMC or other fresh cells is placed in contact with that immobilised antibody. About 30% of the PBMC are CD8+ cells. In the PBMC of a patient who has recovered from a previous influenza virus infection, about 1 CD8+ cell in 10^5 - 10^6 is a memory cell that has been pre-sensitised to a specific epitope associated with the influenza virus.

The method of the invention involves adding a peptide to the fluid. The peptide may be a known epitope for a well characterised viral infection; or may be a candidate epitope possibly associated with a less well characterised viral infection. The resulting fluid mixture is incubated under conditions to stimulate any peptide-specific T-cells that may have been pre-sensitised to that particular virus-derived peptide *in vivo*. The peptide needs to be of a length, e.g. 7 - 15 and particularly 8 – 12 or 8 - 10 amino acid residues long, that is recognised by CD8+ cells. It is supposed that the generality of the CD8+ cells (and other PBMC) present the peptide to the small minority of CD8+ cells that may have been pre-sensitised to the peptide. If such activated or pre-sensitised peptide-specific T-cells are present in the test fluid, they respond by secreting IFN-γ or other cytokine which then becomes bound to the immobilised antibody.

It is preferred that the peptide be added in uncombined form to the fresh cells. While it is possible to add cultured cells that have been pulsed with the peptide, this is not necessary when using defined peptide epitopes. The peptides should be added in an amount sufficient to generate an observable signal; a preferred concentration range in the fluid is 0.01 up to 100 μM particularly 0.5 - 5.0 μM.

Incubation should be continued for a time sufficient to permit CD8+ cells that have been pre-sensitised *in vivo* to the particular peptide

chosen to secrete the IFN-γ or other cytokine. The incubation should not continue for so long that quiescent CD8+ cells have time to differentiate and become activated by the peptide and start to secrete cytokines. This suggests an incubation time of 4 - 24 hours, more particularly 6 - 16 hours. It is an advantage of the invention that the incubation part of the test can be performed in a single working day or overnight, and without the use of sterile conditions required for cell culture *in vitro*.

During the incubation, any IFN-γ or other cytokine secreted by CD8+ cells becomes bound to the first antibody immobilised on the surface. After incubation, the surface may be washed to remove unbound material. For detection, preferably a labelled second antibody to the cytokine is used. When this is applied to the surface it becomes bound to any cytokine present. The second antibody should preferably recognise a different epitope from the first antibody. One or both of the first and second antibodies should preferably be monoclonal. The label may be any that is conventionally used in the field, including radioisotopes, enzymes to generate colour or chemiluminescence, fluorescent groups or groups for detection by mass spectrometry or refractive index (e.g. by surface plasmon resonance). It is convenient but not necessary to use a labelled antibody, any reagent that binds specifically to the cytokine could be labelled and used. Detection and perhaps quantitation of the label is effected by means well known in the field and appropriate to the nature of the label used.

The assay may conveniently be carried out in a multiwell plate. Each well of the plate has a surface carrying a bound first antibody. To each well is added a fluid containing an appropriate number, e.g. 10^3 - 10^6 of cells. Different peptides and/or controls are added to individual wells of the plate. Cells that secrete a cytokine during incubation show up as spots (spot forming cells or SFCs) and the number or density of these in each well can readily be determined.

The assay technique has a number of advantages over prior known techniques:-

a) It is quicker and more convenient; the duration of the assay is only 6 hours and thus does not require sterile conditions or technique. Current methods of enumerating precursor effector T cells require *in vitro* culture with the specific antigen and autologous feeder cells in a limiting dilution assay (LDA). The method is laborious and time consuming.

b) It requires minimal technical equipment and is suitable for field conditions in the tropics and developing countries as well as routine diagnostic laboratories. The LDA, by contrast, requires many peripheral blood lymphocytes, a source of gamma irradiation to inactivate the feeder cells and sterile conditions, as the cells need to be cultured for 1-2 weeks.

c) It is safe and non-radioactive. In the LDA, however, the cultured cells are assayed in a cytotoxic T cell assay (CTL) assay using the radioactive isotope chromium-51.

d) It is an immediate *ex vivo* assay. As such it measures effector cells in their natural state without the introduction of unknown biases that occur as cells proliferate *in vitro* culture with antigen and exogenous cytokines.

e) The assay is performed over only 6 hours; as such it measures peptide-specific effector cells directly, without requiring these cells to proliferate *in vitro*. The short duration of the assay also eliminates the possibility that the cells may be becoming activated *in vitro*; it therefore measures effector function that is present *in vivo*. LDAs require the cells to proliferate many fold; however many effector cells do not proliferate in these conditions and therefore the result of the LDA is often an underestimate of the true number of circulating effectors.

The assay technique is expected to be of value in a number of different ways:-

i) For research into the mechanisms involved in peptide

presentation and recognition and activation. Through the experimental work described in outline below, the inventors have gained insight into the phenotype and effector function of antigen-specific T-cells freshly isolated from peripheral blood.

ii) For quantifying peptide-specific effectors in HIV-infected individuals direct from peripheral blood.

iii) For monitoring the progress of, or resistance to, a chronic infectious disease, for example in response to a drug or therapeutic vaccine. This is expected to be particularly useful for HIV, Hepatitis B and Hepatitis C.

iv) For identifying peptides that may be implicated in a disease state (Epitope mapping), an important preliminary step in the design of a new vaccine. This is expected to be of interest for tuberculosis, malaria and HIV.

v) For monitoring the extent to which a patient, who has suffered from a particular disease such as influenza, may be resistant to future infections.

vi) For monitoring induction and maintenance of CD8+ and CD4+ antigen-specific T cells following immunisation with experimental preventative vaccines, e.g. malaria.

The following examples illustrate the invention.

EXAMPLE 1

Immunological Memory to Influenza Virus: *Ex Vivo* Enumeration and Characterisation of Circulating Peptide-Specific CD8+ Activated T Cells in the Memory State

Subjects were healthy laboratory personnel or healthy adult volunteers, who were HLA typed serologically by complement mediated lymphocytotoxicity. 5 MHC Class I-restricted influenza epitopes were used

and are listed in Table 1.

96-well PVDF-backed plates were coated with 100 µl of 15 µg/ml of the anti-IFN-γ Mab 1-DIK overnight at 4° or at room temperature for 3 hours. The plates were washed and then blocked with R10 (standard tissue culture medium containing 10% fetal calf serum) for 1 hour at room temperature. PBMC of the subjects were separated from heparinised whole blood by centrifugation, resuspended in R10 and added in a final volume of 100 µl R10/well to the 96-well PVDF backed microtitre plates. Input cell numbers were usually 5 $x10^5$ per well, and all assays were done in duplicate wells. Peptides were usually added to a final concentration of 1-2 µM, except in one peptide titration experiment where the concentration of the M1 58-66 peptide was diluted to 20 nM. Assays were usually performed for 12-14 hours, but certain assays were performed for 6 hours to confirm that the antigen-specific cells were capable of immediate effector function. Incubation was carried out at 37°C in an atmosphere containing 5% CO_2. Incubation was arrested by shaking off the contents of the wells and washing. Then 100 µl of 1 µg/ml of a biotinylated second anti-IFN-γ MAB 7-B6-1-biotin (Mabtech, Stockholm, Sweden) was added to the wells and the plates incubated for 3 hours. 100 µl of 1:1000 dilution of streptavidin-alkaline phosphatase conjugate was added to the wells and the plates incubated at room temperature for a further 2 hours. The wells were again washed, and 100 µl of chromogenic alkaline phosphatase substrate diluted 1:25 with deionised water was added to the wells. After a further 30 - 60 minutes incubation at room temperature the wells were washed to terminate the colorimetric reaction. The spots were counted under x20 magnification with a dissecting stereomicroscope.

Results

Using 5 well-defined HLA Class I-restricted influenza

epitopes, free peptide was added to a final concentration of 2 μm directly to the freshly isolated PBMC in the ELISPOT assay. For almost all the individuals tested in this way, using epitopes restricted by HLA Class I alleles present in the individual, IFN-γ secreting peptide-specific effector T-cells were detected. Table 1 summarises the responses to these five epitopes. Most of these assays were performed over 12 - 14 hours, and Figure 1 is a bar chart showing the response at different concentrations of PBMC per well. However, to exclude the possibility that memory T-cells might proliferate or become activated *in vitro* during the course of a 14 hour assay, 6 hour assays were also performed. Peptide-specific SFCs were detected as shown for the same M1 58-66 epitope quantitatively in Figure 2. For a negative control, irrelevant peptides from infectious agents which the donor was not infected were added directly to the fresh PBMC.

Most experiments were performed at final peptide concentrations of 2 μm. However, responses were still readily detectable when peptide concentrations were reduced down to 0.02 μm, as shown in Figure 3 for the influenza HLA-A2.01-restricted matrix epitope.

Depletion of CD8+ T-cells from fresh PBMC with anti-CD8 antibody-coated magnetic beads completely abrogated the peptide-specific response, confirming that the effectors giving rise to the spots elicited by known Class I-restricted epitopes are CD8+ T lymphocytes. Conversely, depletion of CD4+ cells did not diminish the number of IFN-γ SFCs, indicating that neither CD4+ nor their cytokine products were required for the acquisition or deployment of effector function by the freshly isolated peptide-specific CD8+ T cells. Immediate effector responses were only detected to influenza epitopes restricted by the HLA Class I alleles present in the particular donor being tested; addition of influenza epitopes restricted by HLA Class I molecules not present in the donor never resulted in SFCs. (data not shown).

While expansion of peptide-specific CD8+ effector CTL

during acute influenza renders the cells detectable by means of the known ^{51}Cr release cytotoxicity assay performed with fresh uncultured PBMC, after recovery from the acute illness, such cells are no longer detectable. It appears that this is not because they are absent, but rather because they are present at too low a frequency to be detectable. After recovery from the acute illness, such cells remain detectable by the ELISPOT assay technique of the present invention.

Counting the spots under magnification, and comparing this number to the input number of fresh PBMC gives a measure of the relative frequency of circulating activated peptide-specific CD8+ effectors in peripheral blood. The frequency of IFN-γ-secreting CD8+ effectors for the HLA-A2.1-restricted epitope M158-56 in donor WB was measured by the invention assay (1/15000) and by conventional limiting dilution analysis (LDA) (1/103000).

Table 1. Class I-restricted influenza epitopes recognised by freshly isolated CD8+ effector T cells

Protein	Sequence	MHC class I restriction	No of Responders	No of donors tested
M1 58-66	GILGFVFTL	A2.01	6	6
NP 380-388	ELRSRYWAI	B8	3	4
M1 128-135	ASCMGLIY	B35	2	2
NP 265-273	ILRGSVAHK	A3	1	2
NP 383-391	SRYWAIRTR	B27.05	1	1

The above experiment is described in greater detail in J. Exp. Med., 186, 6, September 15, 1997, 859-865, which is incorporated herein

by reference.

EXAMPLE 2

Application to quantifying peptide-specific effectors in HIV-infected individuals direct from peripheral blood

Cryopreserved peripheral blood lymphocytes (PBL) that had been freshly isolated from the peripheral blood of patient 868 were plated out at 50,000 cells per well of a PVDF coated 96 well plate, which had previously been coated with anti-interferon-gamma monoclonal antibody. Duplicate wells were set up for each antigen. Two types of duplicate control wells were used: no peptide and an irrelevant HIV gag epitope restricted through HLA-B8, an HLA allele not present in patient 868.

A range of peptides and their respective naturally occurring variants (previously identified in patient 868) were added directly to the cells at a final concentration of 2 μM. The plate was incubated for 12 hrs at 37°C in 5% CO_2 and developed as previously described (see Example 1). The resulting spots were counted with a x40 dissection microscope. These results are presented in tabular form in Figure 4.

EXAMPLE 3

Identification of CD4+ and CD8+ Epitopes in Secreted Antigens of M. Tuberculosis

Mounting evidence points to a protective role for CD8+ cytotoxic T lymphocytes in *Mycobacterium tuberculosis* infection, but *M. tuberculosis*-specific CD8+ T cells have not hitherto been identified in man. Using a reverse immunogenetic approach, the inventors have synthesised an array of candidate HLA Class I restricted peptides from two immunodominant antigens of *M. tuberculosis*, ESAT-6 and antigen 85. The inventors have screened 75 subjects representing a broad clinical

spectrum of *M. tuberculosis* infection. Peripheral blood lymphocytes were stimulated *in vitro* with the peptides and then tested for cytotolytic activity in a ^{51}Cr release assay and for single cell interferon-γ release in an ELISPOT assay. The inventors have identified several octamer and nonamer epitopes from ESAT-6 and antigen 85 in patients and exposed contacts. Certain epitopes are recognised by CD8+ lymphocytes in an MHC Class I restricted manner; others are recognised preferentially by CD4+ T cells.

The sequences of ESAT-6 and antigen 85A, B and C were scanned with allele-specific peptide motifs for the HLA class I types -A2, -B7, -B8, -B35, -B52 and -B53 all of which were present in the study population.

For ESAT-6, sequences congruent with the peptide motifs for HLA-A2, -B8 and -B52 were identified; these peptides were synthesised and are displayed in Table 2. No sequences congruent with HLA-B7, -B35 and -B53 were present in ESAT-6 and thus no peptides were synthesised for these HLA class I alleles. Peptides were sorted into pools that were used for *in vitro* restimulation of donor PBMC. Peptides found to be CD8+ epitopes are shown in boldface. Similarly, 42 peptides were synthesised based on the sequences of antigens 85A and 85C. No CD8+ epitopes were identified amongst these and the peptides are not shown.

Table 2

HLA class I allele	Peptide motif	Peptide	Sequence	Position
HLA-A2	-L/I/M-----V/L/I	ES8	GIEAAASAI	10 – 18
		ES9	AIQGNVTSI	17 – 25
		ES10	LLDEGKQSL	28 – 36
		ES11	ELNNALQNL	64-72
		ES13	**AMASTEGNV**	82 – 90
HLA-B8	--K-K---L/I	ES7	EGKQSLTKL	31 – 39
HLA-B52	-Q----I/V	ES12	**LQNLARTI**	69 – 76

ELISPOT assay for IFN-γ.

96-well PVDF-backed plates pre-coated with the anti-IFN-γ mAb 1-DIK at 15 μg/ml were washed with RPMI and blocked with R10 for 1-h at room temperature. In one experiment, 500,000 freshly isolated uncultured PBMC were used per well. In another experiment short term cell lines (STCL) or CD8+ cytotoxic T lymphocytes (CTL) or clones were washed x 2 in RPMI, resuspended in R10, and dispersed at known cell input number/well in duplicate wells. Responses were considered significant if a minimum of 10 SFCs were present per well and additionally this number was at least twice that in control wells. Peptide was added directly to the supernatant at a final concentration of 2 μl (free peptide). Plates were incubated for 12 hrs at 37°C, 5% CO_2. After washing x 6 with phosphate buffered saline 0.05% Tween-20 to remove cells, plates were incubated for 3 hrs with the second biotinylated anti-IFN-γ mAb 7-B6-1-biotin at 1 μg/ml. A further wash as above was followed by incubation with a 1:1000 dilution of streptavidin-alkaline phosphatase conjugate for 2 hrs. After another wash, chromogenic alkaline phosphatase substrate was

added to the wells and 30 mins. later plates were washed with tap water. After drying, spot forming cells (SFC) were counted under x 20 magnification.

STCL were generated by the method described in Nature 346 (1990) 183-7. CD8+ T-cell clones were generated by standard methods.

Identification of ESAT-6 specific effector T cells direct from peripheral blood.

Two CD8+ epitopes in ESAT-6 were identified. The T cells from donor NPH54, who had tuberculous mediastinal lymphadenitis recognised peptides corresponding to both of these epitopes. Uncultured PBMC isolated at the time of diagnosis from NPH54, who has HLA-B52 and HLA-A2.01, secreted IFN-γ in response to an ESAT-6-derived peptide pool for these class I alleles in an *ex vivo* ELISPOT assay. The mean number of IFN-γ spot-forming cells (SFCs) enumerated from 5×10^5 PBMC in duplicate wells was 19 for the ESAT-6 peptides compared to 2 in the control wells with no peptide. A subsequent assay tested freshly isolated PBMC against each of the individual peptides within the responding pools; IFN-γ SFCs were detected in response to peptides ES12 and ES13, whose sequences are congruent with the HLA-B52 and HLA-A2.01 peptide motifs respectively. The frequency of ES12- and ES13-specific IFN-γ SFCs is of the same order of magnitude as SFCs for HLA-A2.01-restricted influenza matrix epitope M1 58-66. Unrestimulated PBMC from a second donor, NPH97, with tuberculous osteomyelitis, also recognised the ES12 peptide. This patient also has HLA-B52 and -A2.01 and the magnitude of the ES12-specific response was similar to the response to the HLA-A2-restricted influenza matrix epitope. Single cell IFN-γ release by freshly isolated T cells in these short 12 hr ex vivo assays, employing no stimulus other than cognate peptide, indicates that these cells are highly likely to be circulating activated effector T cells.

EXAMPLE 4

Application to Malaria

The assay method of this invention has been used effectively to track the induction of antigen-specific cellular immune responses induced by immunisation with a novel malaria vaccine candidate RTS.S. This vaccine candidate includes most but not all of the peptide sequence of the circumsporozoite protein (CSP) antigen, a 412 amino acid protein. PMBC of 10 healthy volunteers were obtained and analysed before, during and after a standard three-dose vaccination. 25 15-mer peptides spanning the entire amino acid sequence of the CSP antigen contained in RTS.S were used to detect epitope specific T-cells. An *ex vivo* ELISPOT assay for IFN-γ was performed, using these peptides, generally as described in Examples 1 and 3 above. The results showed that vaccination with RTS.S caused the production of circulating activated T-cells which responded to several of the oligopeptides used in the assay, in all ten volunteers. These experiments demonstrated that high frequencies (up to 1/10,000 PBMC) of T-cells specific for certain peptides were induced by vaccination with RTS.S. The peptides that were most strongly recognised were those from the Th2 region and the conserved Region II of CSP suggesting that responses to those sequences of *P. falciparum* CSP may mediate protective immunity. Ongoing studies are applying the assay technique to study cellular immune responses induced by RTS.S in phase I/II infectious mosquito bite challenge studies and in field studies in Africa.

CLAIMS

1. A method of assaying for peptide-specific T-cells, which method comprises providing a fluid containing T-cells, adding a peptide to the fluid, incubating the fluid to cause cytokine release, and detecting the released cytokine.

2. A method as claimed in claim 1, which method comprises providing the fluid containing T-cells in contact with a surface carrying an immobilised first antibody to the cytokine, adding the peptide to the fluid, incubating the resulting fluid mixture under conditions to cause any peptide-specific T-cells that have been pre-sensitised to the peptide to secrete the cytokine, and detecting any secreted cytokine bound to the immobilised first antibody.

3. A method as claimed in claim 1 or claim 2, wherein the T-cells are peripheral blood mononuclear cells.

4. A method as claimed in any one of claims 1 to 3, wherein the peptide-specific T-cells are CD8+ or CD4+ cells and the cytokine is IFN-γ.

5. A method as claimed in any one of claims 1 to 4, wherein the peptide is 7 - 15 amino acid residues in length.

6. A method as claimed in any one of claims 1 to 5, wherein the resulting fluid mixture is incubated under non-sterile conditions.

7. A method as claimed in any one of claims 1 to 6, wherein the peptide is a known epitope.

8. A method as claimed in any one of claims 1 to 7, wherein the T-cells are taken from a patient known to be suffering, or to have suffered from, infection with an intracellular pathogen.

9. A method as claimed in any one of claims 1 to 8, performed to monitor progress of HIV infection.

10. A method as claimed in any one of claims 1 to 8, performed to monitor the effect of a vaccine.

11. A method as claimed in any one of claims 1 to 8, performed to determine a pathogen-derived epitope targeted by CD4+ or CD8+ T cells.

12. A method as claimed in any one of claims 1 to 11, applied to the study of Hepatitis B, Hepatitis C, tuberculosis, malaria, HIV or influenza.

Fig.1.

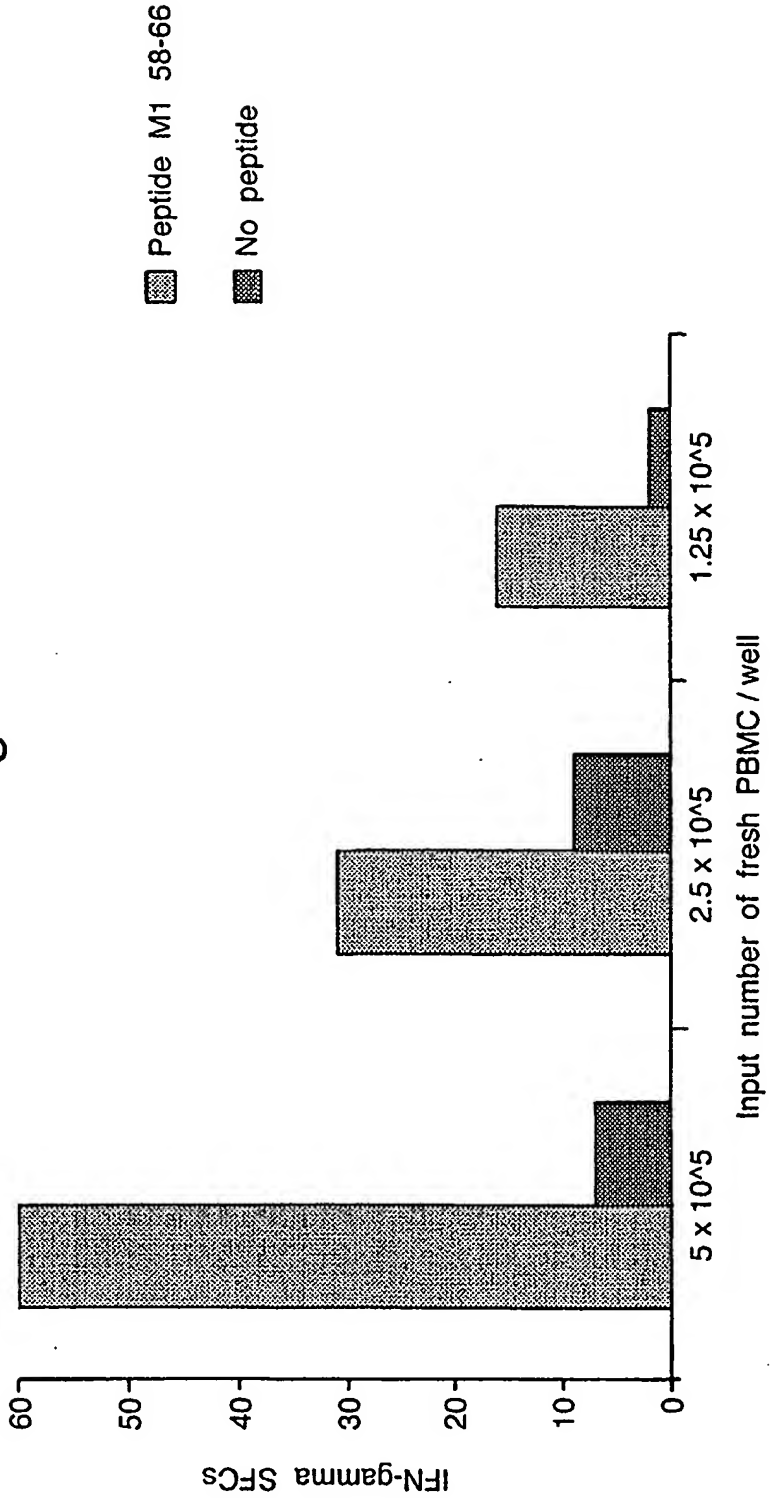


Fig.2.

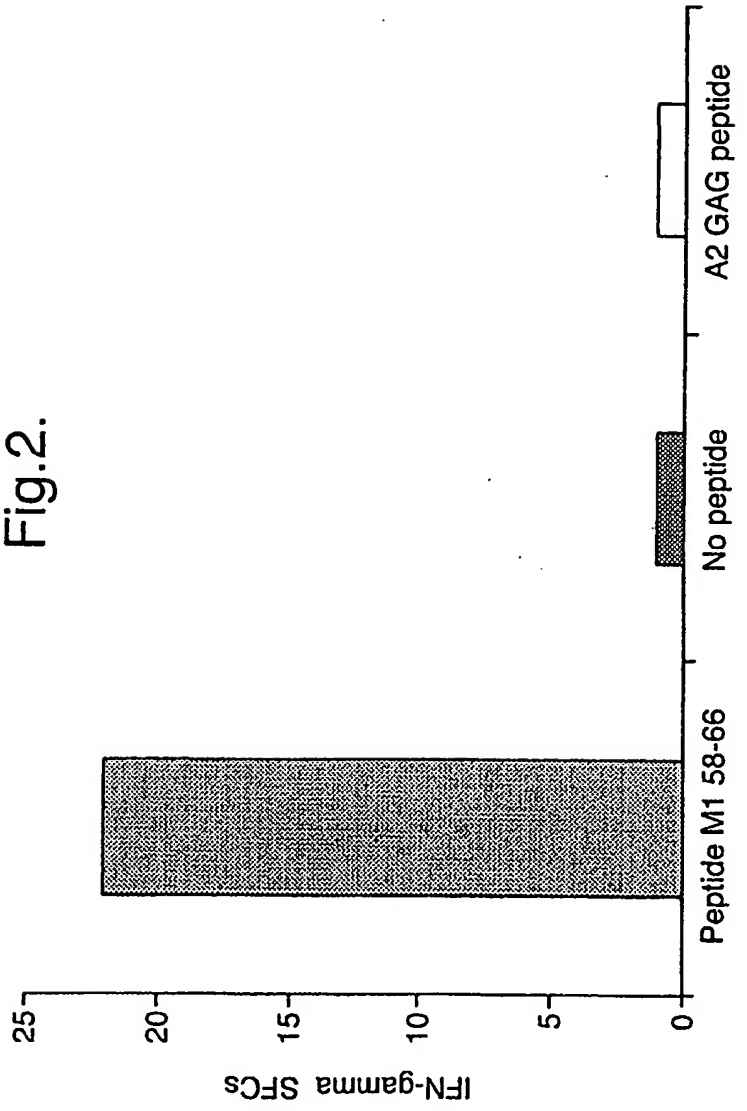
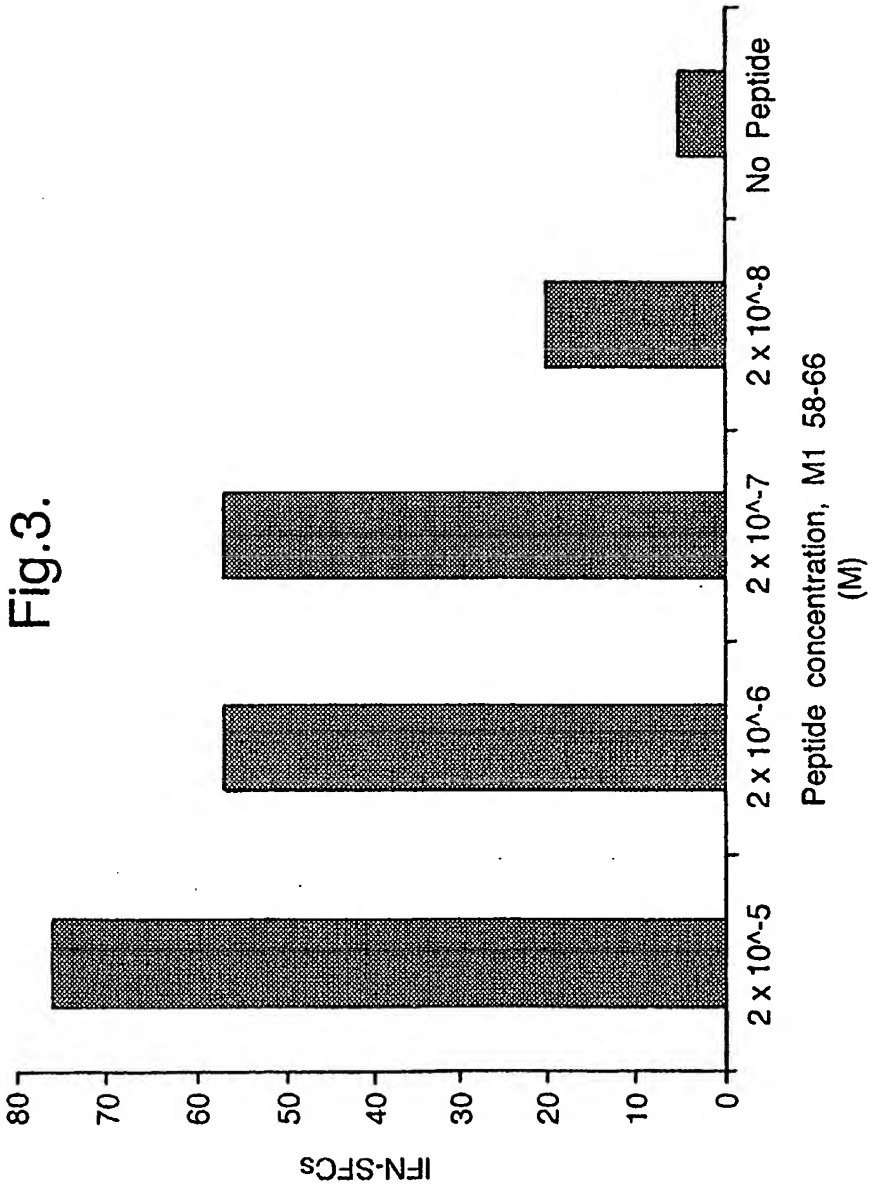


Fig.3.



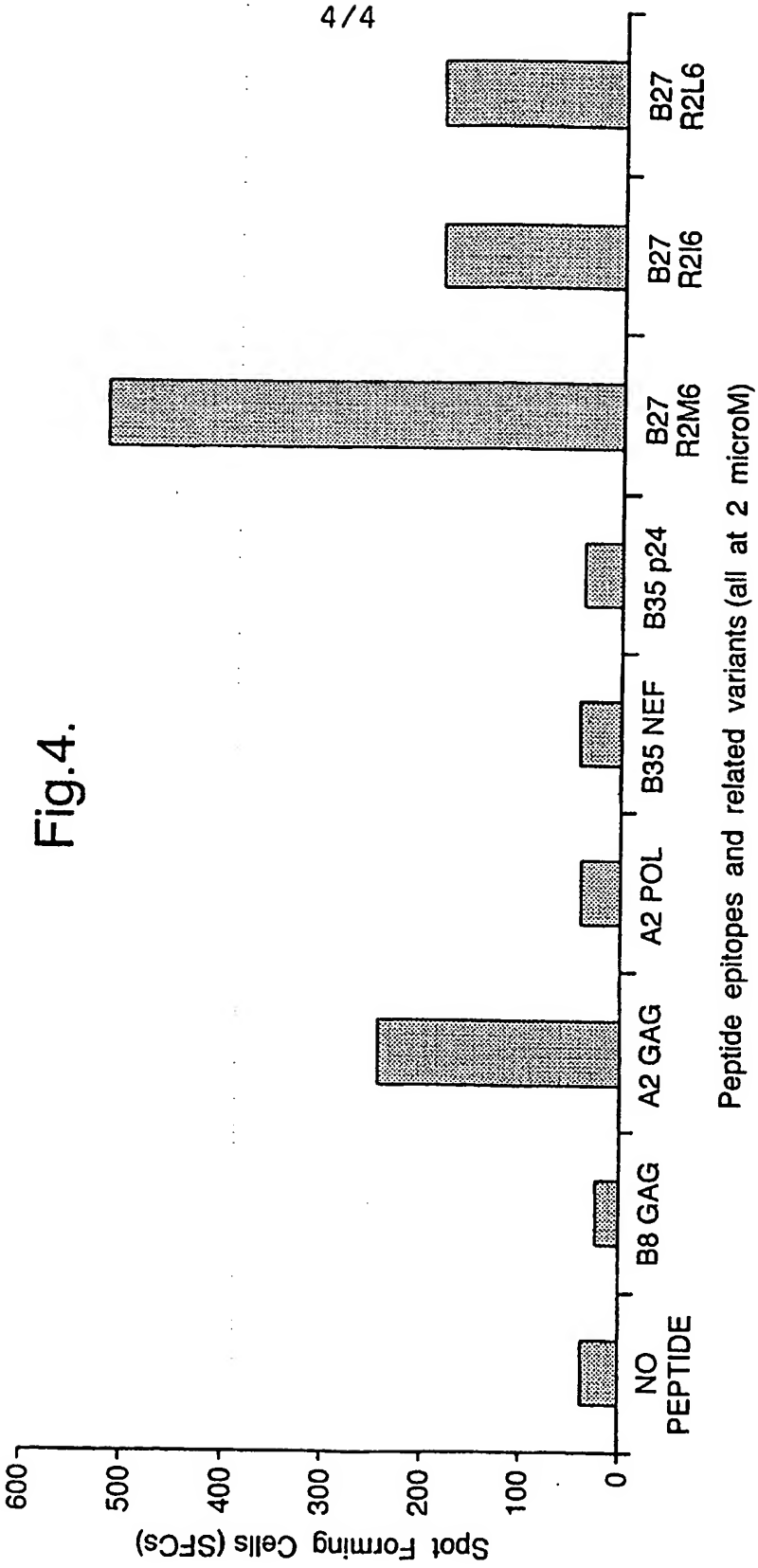


Fig.4.

INTERNATIONAL SEARCH REPORT

	International Application No PCT/GB 97/03222

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01N33/569 G01N33/68 G01N33/543

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 97 00067 A (UNIV VICTORIA ;NANO FRANCIS E (CA)) 3 January 1997 see final paragraph page 6-first paragraph page 7 see page 15, line 28 - page 17, line 28	1-12
P,X	DE 195 25 784 A (BOEHRINGER MANNHEIM GMBH) 16 January 1997 see claims 24-26,31,32 see page 6, line 62 - page 7, line 14	1,3,8

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[X] Further documents are listed in the continuation of box C.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
10 March 1998	17/03/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Routledge, B

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 97/03222

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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